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EFFECTIVENESS OF A HIDROSTAL PUMP IN THE LIVE TRANSFER OF AMERICAN EELS - FIELD STUDY 1985

Report No 85-312-K

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ABSTRACT

The effectiveness of a Hidrostal pump in the live transfer of American eels (Anguilla americana) was field-evaluated at Saunders GS. A total of 2300 eels was passed successfully through the pump with no mortality. Fish injury was minimal averaging less than 3% over all test conditions. The Hidrostal pump is recommended for transferring eels during dewatering practices at Saunders GS.

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INTRODUCTION

Upstream migrating American eels (Anguilla americana) have caused serious operational problems at the R.H. Saunders Hydro-electric Power Dam on the St. Lawrence River near Cornwall, Ontario. When the upper flow control gate is closed, resulting in a gradual reduced current flow, large numbers of eels swim into the turbine housing before the lower control gates can be lowered. The large number of eels present in the turbine clog the pump intakes preventing unit dewatering. A study was initiated in 1984 to evaluate the effectiveness of a Hidrostal pump as a method to return fish back into the river system before the unit was de-watered. Initial laboratory experiments were successful and indicated the potential for using this pump in the live transport of eels (Ontario Hydro Research Division Report No 84-150-K). However, before the pump was considered for use at Saunders GS, an "in-situ" field evaluation was considered necessary. The objective of this study was to field-evaluate the effectiveness of a Hidrostal pump in the live transfer of American eels at Saunders GS.

MATERIALS AND METHODS

Test animals

Approximately 2500 upstream migrating American eels (Anguilla americana) were collected from the eel ladder (Whitfield and Kolenosky 1978) at Saunders GS in early September 1985 with the assistance of the Ministry of Natural Resources. Eels ranged in size from approximately 27 to 52 cm.

Fish pump and transport system

A submersible Model 16-F Hidrostal pump was used in these tests. This pump is designed for free passage of solid objects up to approximately 15 cm in diameter. The pump consisted of a screw-type impeller, and was powered by a 75 hp motor.

The proposed installation of the Hidrostal pump at Saunders GS is in the draft tube dewatering sump. Once a unit is being dewatered, eels would be pumped from the draft tube of one unit to the draft tube of another, or directly to the tailrace. However, poor access to the draft tubes to collect eels for evaluation prevented evaluation of the pump at this location. As an alternative, experiments were conducted in the forebay on top of the dam (Figure 1). An attempt was made to simulate operating conditions (eg, impeller speed, discharge velocity, head) similar to that expected in the draft tubes. The pump was operated at a fixed impeller speed of approximately 1200 rpm (revolutions per minute), and was submersed approximately 2 m below the water using a crane. The intake pipe, 15 cm in diameter, was approximately 0.6 m in length. The discharge transport pipe was 20 cm in diameter, and approximately 7 m in length which included three 45° elbows. The calculated head of the transport system was over 10 m, considerably less than that proposed in the draft tube installation (20-30 m). Estimated water velocities in the transport system exceeded 5.2 m, with a discharge rate of approximately 10600 L/min (2800 US gpm). This velocity exceeded that expected in the draft tubes.

At the beginning of a test, fish were placed in a pipe system which fed directly into the pump intake. This pipe was necessary since eels actively avoided the intake mouth. Eel avoidance of the intake mouth is not a major concern in the proposed installation since the pump will be located in a sump area. A screened cage (approximately 2 cm square mesh) allowed water to be drawn into the intake yet prevented escape of eels.

Experimental design

The effectiveness of the Hidrostal pump in the live transfer of American eels was evaluated relative to fish density. Four tests were conducted using 25, 50, 100 and 200 animals. Two tests were also conducted using 400 animals per trial. These numbers corresponded to densities ranging from approximately 34 to 547 animals/100 L of water. At the highest density we far exceeded the capacity of the pump (for optimum efficiency) in the passage of solids in an aqueous environment (which is 40% solid, 60% liquid).

Eel survival was determined immediately following pump passage (time 0 h), and at times 24, 48, 72, 96 and 148 h. Immediately following passage, eels were placed into separate modified hoop nets (6.3 cm ACE mesh, 1.2 m x 1.0 m x 1.0 m) and held over the specified time periods. At each time interval, eels were also examined for external injury. Controls were also conducted to determine mortality due to holding. No control mortality occurred.

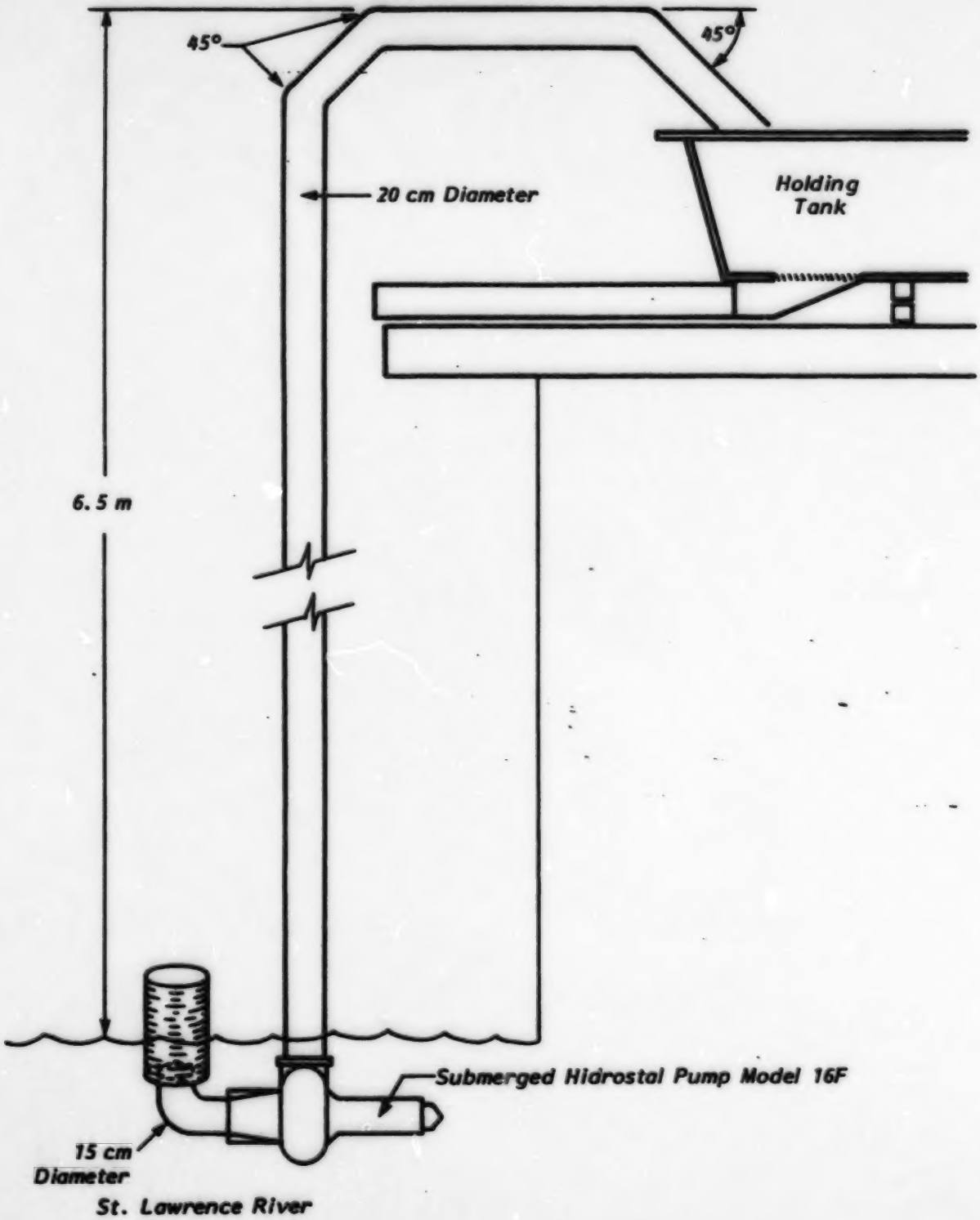

FIGURE 1

GENERAL LAYOUT OF HIDROSTAL PUMP AND TRANSPORT SYSTEM

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RESULTS AND DISCUSSION

Fish survival

A total of 2300 eels was passed successfully through the pump system with no mortality (Table 1). These results were supportive of the laboratory tests even though fish densities, head and discharge velocities were substantially higher than that tested under laboratory conditions (Ontario Hydro Research Division Report No 84-150-K). It was also noteworthy that in some of the field tests the fish/water ratio was 0.80 which far exceeded the capacity of the pump in pumping objects with optimum efficiency. These latter results are significant since one would expect a high ratio of fish to water if the pump is installed in the draft tubes. Fish injury was also minimal averaging less than 3% for each test (Table 2). Although some fish suffered abrasions there was no evidence of latent mortality.

RECOMMENDATIONS

Both laboratory and field results indicated that the Hidrostal pump was quite effective in passing eels unharmed under different fish densities and impeller speeds. Eel avoidance of the pump intake is not considered a problem in the proposed installation since the pump will be located in a sump area. If the pump is located in the forebay (open water) an attractant will probably be required to move eels towards the pump intake. Based on survival results, we recommend that this pump be used to transfer eels during dewatering practices at Saunders GS.

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TABLE 1. Effectiveness of a Hidrostal pump in the live transfer of American eels (Anguilla americana)

No of tests	No animals/ test	Approximate density No animals/ 100 L	Fish/Water Ratio	Per cent survival following passage					
				0 h	24 h	48 h	72 h	96 h	148 h
4	25	34	0.043	100	100	100	100	100	100
4	50	68	0.085	100	100	100	100	100	100
4	100	136	0.169	100	100	100	100	100	100
4	200	273	0.402	100	100	100	100	100	100
2	400	547	0.804	100	100	100	100	100	100

TABLE 2. Number and type of injury of eels after passage

No of tests	No animals/ test	Total no animals	No injured	Type of injury	
				bruise	abrasion
4	25	100	1	1	0
4	50	200	1	1	0
4	100	400	11	1	11
4	200	800	6	6	0
2	400	800	2	1	1

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